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(54) MELT-BLOWN SPINNING APPARATUS

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[Amendments have been incorporated into text of translation.]

CLAIMS

1. A melt-blown spinning apparatus, characterized by the melt-blown spinneret die block being fitted with two or more single resin flow-control parts, one combined resin flow-control part, and a number of spinning orifices.

2. The melt-blown spinning apparatus described in Claim 1, characterized by the length of the single resin flow-control part being longer than that of the combined resin flow-control part.

3. The melt-blown spinning apparatus described in Claim 1 or 2, characterized by the ratio of the combined resin flow-part length (L_3) to its thickness (T_3) satisfying the equation:

$$L_3/T_3 < 20$$

4. The melt-blown spinning apparatus described in any of Claims 1-3, characterized by the pitch of the spinning orifices being less than 5 mm.

5. The melt-blown spinning apparatus described in any of Claims 1-4, characterized by satisfying the equation:

$$R/S < 2000$$

wherein R is the area of cross section perpendicular to the flow direction of the combined resin flow-control part and S is overall area of cross sections perpendicular to the flow direction of the spinning orifices.

6. The melt-blown spinning apparatus described in any of Claims 1-5, characterized by inserting a static mixer through a cylindrical part installed between the combined resin flow-control parts and the spinning orifice.

DETAILED EXPLANATION OF THE INVENTION

INDUSTRIAL APPLICATION FIELD

The present invention concerns the spinneret block of a melt-blown spinning apparatus for obtaining fibers by extruding a molten or liquid resin into a high-speed gas jet through a spinneret consisting of a large number of fine orifices.

CONVENTIONAL TECHNOLOGY

The melt-blown spinning process involving the spinning of a high-molecular-weight resin melt or solution through a number of fine orifices into a high-speed jet of steam or gas such as air, etc., in the spinning width direction provides very fine fiber webs in one step simply and economically, thus it is very useful for making nonwoven fabrics.

In general, this process is known in Japanese Kokai Patent Nos. Sho 49[1974]-10258, Sho 49[1974]-48921, and Sho 50[1975]-121570; Japanese Kokoku Patent Nos. Sho 60[1985]-25524, Sho 61[1986]-23284, etc.

Conventionally, in making melt-blown nonwoven fabrics, usually a single resin is spun, while the spinning of two or more resins through a single spinning nozzle is also done for some desired effects, such as imparting hydrophilicity to water-repellent resins, changing the handle, etc.

However, there is a limit in improving the product qualities by mixing resins. For example, in imparting bulkiness to products by imparting coil crimping to fibers, imparting structural changes to the fibers shown in Figure 5 and 6 is difficult.

Japanese Kokai Patent No. Sho 60[1985]-99057 describes an apparatus for making composite blown fiber webs.

However, in using this apparatus:

(1) Unless viscosities of different polymer materials passing through the die are made similar, e.g., even when a separation plate is placed inside the die cavity, the two different polymer materials do not form a uniform layer structure in the die's width direction. For example, one component is concentrated in the middle, and the other component is dispersed to both ends, giving a product with poor uniformity in the width direction, and with a greatly reduced commercial value.

In general, when a product is made by forming two or more polymer materials as a composite, it is favorable when such polymer materials have different properties. However, when such polymer materials having different properties are passed through a die, very often they greatly differ in viscosity, and there has not been a nozzle that is practical in this respect.

(2) In general, in making industrial products with a width of 10-400 cm, even when the viscosities are similar, since there is no flow control in the width direction, the products have no width direction uniformity, and have fluctuating qualities.

PROBLEMS TO BE SOLVED BY THE INVENTION

The present invention is to overcome such conventional problems, and it is an objective of the present invention to provide a melt-blown spinning apparatus for obtaining wide-use industrial products with good uniformity by compositing resins with greatly different properties

and imparting structural changes to the spun fibers for diversification of melt-blow nonwoven fabric products with improved product qualities.

MEANS FOR SOLVING THE PROBLEMS

The present invention concerns:

1. A melt-blown spinning apparatus, characterized by the melt-blown spinneret die block being fitted with two or more single resin flow-control parts, one combined resin flow-control part, and a number of spinning orifices.

2. The melt-blown spinning apparatus described in Claim 1, characterized by the length of the single resin flow-control part being longer than that of the combined resin flow-control part.

3. The melt-blown spinning apparatus described in Claim 1 or 2, characterized by the ratio of the combined resin flow part length (L_3) to its thickness (T_3) satisfying the equation:

$$L_3/T_3 < 20$$

4. The melt-blown spinning apparatus described in any of Claims 1-3, characterized by the pitch of the spinning orifices being less than 5 mm.

5. The melt-blown spinning apparatus described in any of Claims 1-4, characterized by satisfying the equation:

$$R/S < 2000$$

wherein R is the area of cross section perpendicular to the flow direction of the combined resin flow-control part and S is overall area of cross sections perpendicular to the flow direction of the spinning orifices.

6. The melt-blown spinning apparatus described in any of Claims 1-5, characterized by inserting a static mixer through a cylindrical part installed between the combined resin flow-control parts and the spinning orifice.

Namely, in the melt-blown spinning apparatus, each of the two or more resins used has a flow-control part to make the flow uniform in the width direction; two or more flow-controlled resins are combined immediately before spinning, thus the spinning of fibers with a uniform structure in a wide product-width direction becomes possible.

When two or more resins having different properties are composite-spun using the melt-blown spinning apparatus of the present invention, according to the differences in contents and properties, fibers in the form shown in Figure 5 or 6 are uniformly obtained in the wide product-width direction.

For example, when a nonwoven fabric obtained by the spinning of two resins with different thermal shrinkage levels in the form of Figure 6 is heat-treated, an effect similar to that

of a bimetal occurs with the coil crimping of each fiber, resulting in a high-quality nonwoven fabric with a high bulkiness compared with conventional melt-blown nonwoven fabrics.

Next, a practical embodiment of the present invention is explained in detail with figures. However, the present invention is not limited to such a practical embodiment.

Figure 1 shows a melt-blown spinning apparatus of the first example of the present invention; Figure 2 shows its cross-sectional diagram. Figure 1 is the diagram along the A-A line of Figure 2.

The melt-blow die main body (22) is made of stainless steal; on the gear pump seat (19) on its upper part two gear pump-type resin metering pumps (20, 21) are installed.

At the lower part of the main body (22), stainless steal die (23) is mounted by the bolts (27). The upper part of the main body (22) and four sides are fitted with heaters (24) that warm the main body (22). The die main body (22) can be separated into three parts—22-1, 22-2, and 22-3—they are tightly put together by the bolt (22-4) to form the die main body (22). There are two cylindrical resin feed paths (11, 12) with a diameter of 10 mm at the upper part of the main body, connected to the metering pumps (20, 21) via the two resin paths (9, 10) that open through the gear pump seat (19). Resin feeds (11, 12) are connected to nearly conical manifolds (13, 14) narrowing from a diameter of 20 mm to 5 mm.

The manifolds are connected downward to single resin flow-control parts (15, 16) with a width of 303 mm and thickness about 2 mm. The two single resin flow-control parts (15, 16) are open to the combined resin flow-control part (17) of 303 mm in width, 4 mm in thickness, and 15 mm in length at the lower part of the die (23). The single resin flow-control parts (15, 16) are passages of 303 mm in width and about 2 mm in thickness formed by coupling of the protrusion parts of 303 mm in width, 30 mm in thickness, and about 56 mm in length at the lower part of the die (22-2) and the recessed parts of 303 mm in width, 34 mm in thickness, and about 58 mm in length at the upper part of the die (23). At the bottom of the combined resin flow-control part (17), 301 cylindrical spinning orifices (18) of 0.3 mm in diameter and 3 mm in length are open to the outside at a pitch of 1 mm.

Between the lips (31) and both sides of the die (23), there are gaps (30) of 400 mm in width and about 10 mm in length for about a 0.2-mm air jet.

One raw material resin is continuously metered by the metering pump (20) and fed to the resin feed (11) via the resin passage (9), then passed through the single resin flow-control part (15), then to the combined resin flow-control part (17). The other resin is continuously metered by the metering pump (21) and fed to the resin feed (12) via the resin passage (10), then passed through the single resin flow-control part (16), then to the combined resin flow-control part (17). Usually, the two resins joined at the combined resin flow-control part (17) have a viscosity of

10-5000 P, flow rate of about 1-100 cm/min, and are in a laminar flow region and seem to move through the combined resin flow-control part without mixing.

With uniform movement downward through the combined resin flow-control part (17), the fibers spun through the spinning die (18) show no mixing of the two resins with distinct separation of the two resins.

It seems that the longer the single resin flow-control part lengths (L_1, L_2), the better for uniform distribution of the resin in the width direction. However, if too long, an extended dwelling time may result in resin decomposition, thus 10-100 mm is suitable.

Also, it seems that the smaller the single resin flow-control part thicknesses (T_1, T_2), the better for uniform distribution of the resin in the width direction. However, if too small, the pressure loss for the resin passage would be too high, thus 1-6 mm is suitable. Namely, the ratio of the single resin flow-control part length (L_1, L_2) to thickness (T_1, T_2) should be:

$$1.7 < \frac{L_1}{T_1} < 100, \quad 1.7 < \frac{L_2}{T_2} < 100$$

The combined resin flow-control part length (L_3) and the single resin flow-control part length (L_1, L_2) should satisfy the relation shown below:

$$L_3 < L_1, L_2$$

Otherwise, the products would lose the uniformity in the width direction.

If the combined resin flow-control part length (L_3) is too long or its thickness (T_3) is too small, mixing and disturbance between the resins may occur with a loss of uniformity of the fibers, thus maintaining a certain dimensional ratio is preferred, suitably

$$L_3/T_3 < 20$$

If the pitch of the spinning orifices is too large, there may be variations in the resin constitution ratio among the spinning orifices, and often normal spinning cannot be achieved. A pitch of less than 5 mm is suitable.

If the ratio of the area (R) of the cross section perpendicular to the flow direction of the combined resin flow-control part to the combined area (S) of cross sections perpendicular to the flow direction of the spinning orifices is too high, variations in structure may occur among the fibers; thus, the smaller the better, and preferably:

$$R/S < 2000$$

The resin ejected from the spinning orifice (18) is stretched, cooled, and solidified by the high speed gas jet from the slits (30) on both sides of the spinning orifice (18) to form a nonwoven fabric.

As shown by the second example in Figure 3, it is preferred to install filters (41, 42) immediately before the resin is fed to the orifice (18) for the removal of dust and carbides in the resin, which may clog the nozzle.

In Figure 3, the portion corresponding to the die (22-2) described in the first example is divided into the upper part (45) and the lower part (46). The lower part (46) has 21 cylindrical holes (43, 44) of 2 mm in diameter and 15 mm in length, with the addition of filter support plates (46A, 46 B).

The lower die part (46) gives support to the die (23) by the filter supports (46A, 46B), forming the single resin flow-control parts (15, 16) as in the first example, then connected to the combined resin flow-control part (17).

In the second example, the single resin flow-control parts (15, 16) have a width of 303 mm, thickness of 2 mm, and length of about 45 mm, including the part tapered in the forward[-movement] direction of the resin.

Figure 4 is an expanded view of an area from the combined resin flow-control part (17) to the area near the ejection opening (18) of the third example of the present invention.

Below the combined resin flow-control part (17) of 303 mm in width, 4 mm in thickness, and 10 mm in length, a cylindrical part (34) of 3.4 mm in diameter and 22 mm in length, then 75 ejection openings (18) of 0.4 mm in diameter and 4 mm in length at a pitch of 4 mm, are installed.

Inside the cylindrical part (34), there are inserted three 180°-twisted plate elements (35) of 3.4 mm in diameter and 5.1 mm in length in an interconnected manner.

Similarly as in the first example, the two resins passing through the single resin flow-control parts (15, 16) and the combined resin flow-control part (17) are divided into 75 sections at the inlet of the cylindrical part (34).

By the static mixer (35) inside the cylindrical part (34), these are further divided into 8 sections, then ejected through the opening (18) in the form of a 16-section laminate.

Any means having functions of a static mixer can be used. For example, the static division element described in Japanese Kokai Patent No. Sho 60[1985]-45604 can be used.

The nonwoven fabrics obtained from two resins having different thermal properties using the spinning apparatus of the present invention have a finer single fiber fineness, thus it is possible to obtain fine-fiber products, compared with the usual melt-blown nonwoven fabrics.

Using the melt-blown spinning apparatus of the present invention, thermoplastic polymers such as polyolefins, polyamides, etc., can be subjected to melt blowing to obtain high-quality nonwoven fabrics having physical properties and handles not possible in conventional processes.

BRIEF EXPLANATION OF THE FIGURES

Figures 1, 2, 3, and 4 are diagrams of the melt-blown spinning die block of the present invention. Figure 1 is longitudinal cross-sectional diagram along the fiber spinning width direction. Figures 2, 3, and 4 are a portion of longitudinal cross sections perpendicular to the spinning width direction. Figures 5 and 6 are schematic examples of the cross sections of fibers obtained using the melt-blown spinning apparatus of the present invention.

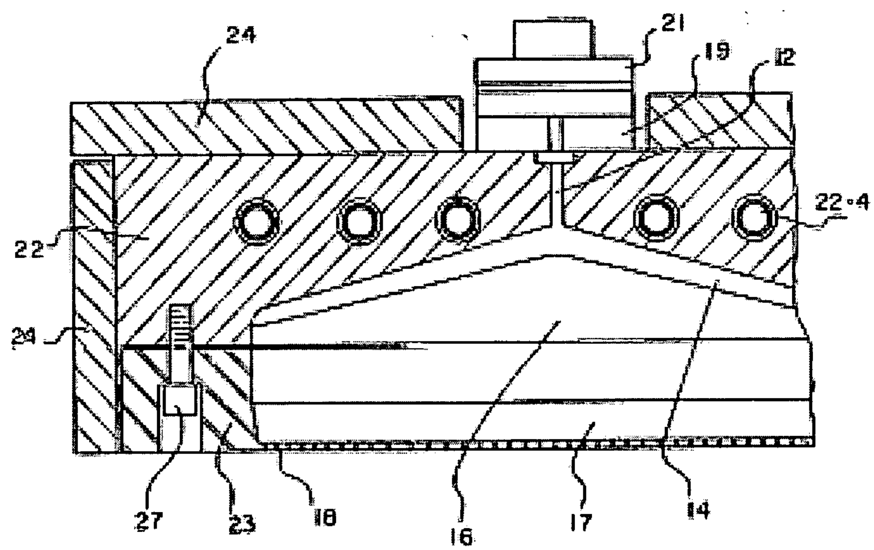

Figure 1

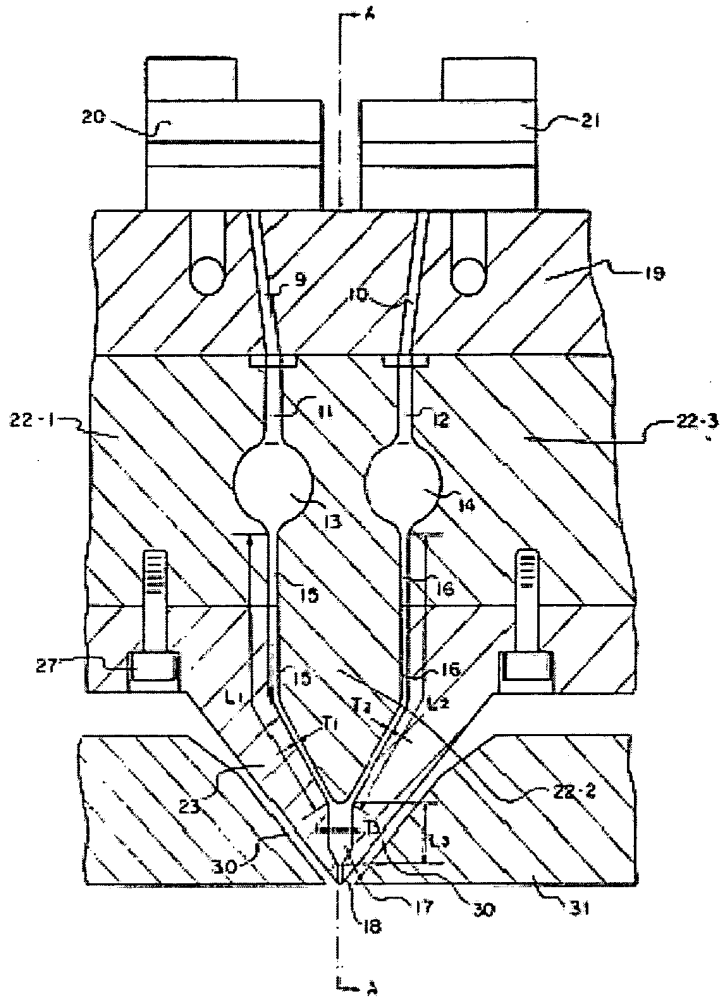
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Figure 2

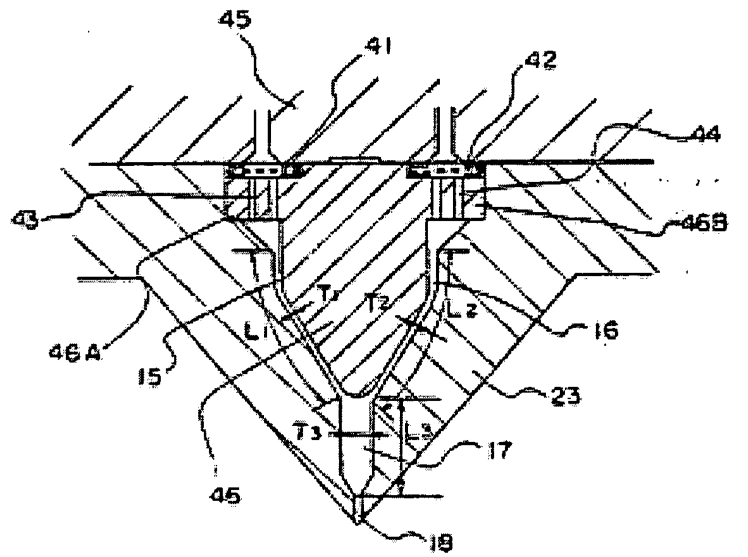

Figure 3

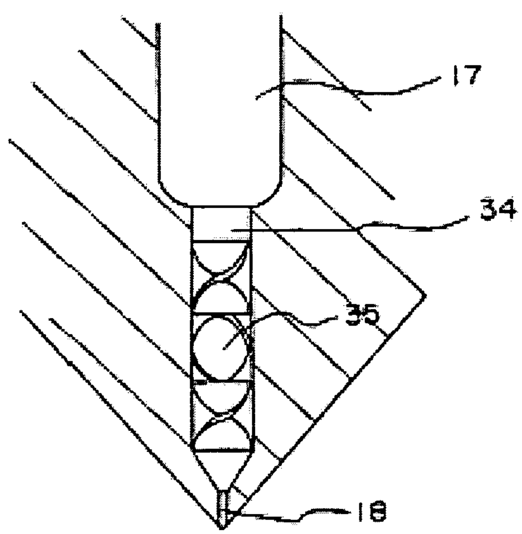

Figure 4

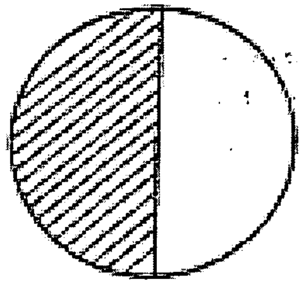

Figure 5

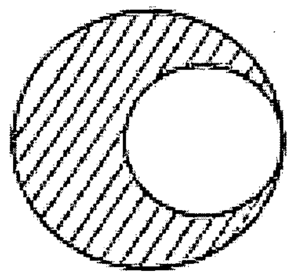

Figure 6

Language Services Unit
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